Summary of net benefit test for opening the Mangamaire bus split for 6 weeks from 30 June

**Purpose**
This document summarises the net benefit test applied to a temporary grid reconfiguration by way of implementing the Mangamaire 110 kV bus split for 6 weeks from 30 June.

**Background**
Lake levels in the South Island are below average for this time of year. We can conserve water in the lakes by transmitting excess generation in the North Island across the HVDC link to the South Island. South transfer relieves some of the need for South Island generation to meet South Island demand. The temporary grid reconfiguration at Mangamaire will allow greater amounts of south transfer.

Clauses 12.116A to 12.116C of the Electricity Industry Participation Code provide for Transpower making temporary grid configurations under certain circumstances. Transpower is required to specify the circumstances for which the grid is temporarily reconfigured and to demonstrate that there is a net benefit arising from the reconfiguration. Transpower is required to publish the circumstances and a summary of the net benefit analysis.

South transfer is limited by the capability of the 110 kV network in the lower North Island. The loss of a 220 kV circuit can cause a parallel 110 kV circuit to overload. Operational splits and special protection schemes have been used on the 110 kV network to allow greater 220 kV transfer. In the past, a split has been implemented at Mangamaire which allowed increased transfer on the 220 kV circuits between Bunnythorpe and Wellington but placed the Mangamaire load on single circuit security. An automatic change-over scheme is available at Mangamaire for this situation which will automatically switch the Mangamaire load to the other in-service circuit following the loss of the single circuit supplying Mangamaire.

The re-conductoring of the Masterton–Mangamaire and the Mangamaire–Woodville circuit relieved the constraint on south transfer caused by these circuits. The 110 kV constraint has shifted to the circuits between Bunnythorpe and Woodville. We are implementing a special protection scheme at Woodville to re-configure the grid when these circuits overload during south transfer. The special protection scheme is expected to be commissioned between 7 and 14 July. Once the scheme is commissioned there is no need for the 110 kV network to be split at Mangamaire.

**Net benefit Methodology**

**Cost of implementing split**
The cost of implementing the split is assumed to be negligible as the hardware is already in place and all that needs to be done is open the circuit breaker and arm the automatic changeover scheme.
**Change in system losses**
Splitting the 110 kV bus at Mangamaire increases system losses by around 2 MW on average. The number of hours over 6 weeks is 1008. Assuming a cost of marginal generation in the North Island of $100 per MWh (based on recent market prices), the upper bound on the cost of increased losses over those 6 weeks is around $200,000.

**Reduction in reliability at Mangamaire**
Splitting the Mangamaire 110 kV bus puts the Mangamaire load on single circuit security. That is, the Mangamaire load is supplied by a single circuit either from the north or south. The loss of the supplying circuit will cause a loss of supply at Mangamaire. Following the loss of the supplying circuit, the auto change-over scheme will switch the Mangamaire load onto the other in service.

Historic fault data indicates that the expected number of forced outages of the Mangamaire-Woodville circuit is 1.9 outages per year. The chance of a successful auto reclose operation following a fault is around 80%. The outage duration is either 1.5 seconds with successful auto reclose or 4 seconds with an unsuccessful auto reclose following the operation of the auto change-over scheme.

The probability of having a fault over 6 weeks on the single circuit supplying Mangamaire is 1.9 faults per year x 6 weeks/52 weeks per year = 0.22.

The peak demand at Mangamaire is around 12 MW. The upper bound for energy not served for an interruption is 12 MW x 4 seconds = 0.01 MWh. The value of energy not served is around $270 with a value of lost load (VOLL) of $20,000 per MWh.

The upper bound for expected energy not served over 6 weeks is 0.22 x $270 (around $60).

**Reduction in risk of needing PCC**

- The cost of media advertising for the public conservation campaign in 2008 was $8 million.
- The cost of energy not served is $85 million.

The total cost is assumed to be $93 million.

Analysis by Energylink indicates there are no inflow trajectories that enter the emergency zone. However, there is one inflow sequence (without the Mangamaire split in place) where the trajectory comes close to the emergency zone.

The benefit of the reduction of the risk of entering into the emergency zone is 1 inflow trajectories out of 80 trajectories. The reduction in risk is around 1% (1/80). This is a reduction in the risk of incurring the cost of a PCC ($93 million). The potential benefit is around $1 million. Even if only 25% of this benefit is realised, the realised amount is more than the cost of increased losses.
The Energylink model takes into account other constraints on south transfer such as the amount of available South Island reserves and market security constraints. Figures 1 and 2 show the South Island Controlled Storage and Risk Curves without and with grid reconfiguration respectively.

**Figure 1:** South Island Controlled Storage and Risk Curve without Mangamaire split

**Figure 2:** South Island Controlled Storage and Risk Curve with Mangamaire split
Outcome of Net Benefit Test

We have identified benefits of at least $250,000 and costs at most around $200,000. There is a net benefit in implementing the Mangamaire 110 kV bus split for 6 weeks from 30 June.

The criterion for which the split is implemented is when one or more of the Controlled Storage and Risk Curve inflow trajectories comes close to the South Island emergency zone.

The criteria for removing the split before the end of 6 weeks from 30 June are:

- when none of the Controlled Storage and Risk Curve inflow trajectories come close to the South Island emergency zone; or
- the new SPS on the Bunnythorpe-Woodville circuits is operational; or
- there is no prospect of south transfer due to planned outages for an extended period (e.g. an outage of pole 2).

The System Operator will continue monitoring the Controlled Storage and Risk Curves on a weekly basis.